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Narcissus Diseases In Washington

By

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[1] In cooperation with U.S. Department of Agriculture.

Narcissus Diseases in Washington

Charles J. Gould

Introduction

The narcissi, or daffodils, grown in Washington at present rank among the world's best in both commercial fields and amateur gardens. Like other flowering plants, however, daffodils are subject to certain diseases which usually are caused by fungi (molds), viruses, or nematodes (eelworms). The general nature of these groups of plant parasites follows.

Fungus Diseases

Fungus diseases are those caused by fungi. These are small and rather simple plants unable to produce their own food because they do not have the green coloring matter (chlorophyll) possessed by higher plants. Fungi must instead feed on living or dead plants and animals. These minute plants usually spread by means of small seed-like bodies called spores, which may be splashed by rain or carried by wind from diseased plants to healthy ones. Fungi may live over one season to the next, either as thread-like growths within a bulb or as hardened lumps of fungus tissue in the soil where the bulb grew. These masses of weather-resisting fungus tissue are usually rounded and hard. They are called sclerotia. Many fungi which cause daffodil leaf diseases form such sclerotia in dead leaves.

Virus Diseases

Viruses, like fungi, cannot manufacture their own food but must get it from living plants or animals. Virus particles are so small that they cannot be seen with an ordinary microscope. When they gain access to a plant, they usually penetrate into every part except the seed. Therefore, whenever a "daughter" bulb is taken from an infected plant, the virus or "disease" also is taken along.

Nematode Diseases

Nematodes are very small thread-like worms, many of which commonly live in the soil without doing any harm, while others attack various plants. The bulb or stem nematode, which is the cause of a serious widespread disease in daffodils, is too small to be seen without a microscope.

General Control Recommendations

Control measures for these parasites are summarized below. Two

excellent general bulletins[1, 2], have been written on daffodil diseases and are recommended to the reader as sources of additional information.

1. Always plant well-graded stock of known disease-free ancestry.

2. If leaf diseases are commonly troublesome, begin spraying when plants are 4-5 inches high and continue at two or three week intervals until the foliage begins to die down. If leaf diseases are not usually serious, a single spray, applied immediately after flowering, should be sufficient. An excellent spray is Bordeaux mixture (4-4-50); that is, 4 pounds of copper sulfate (bluestone), 4 pounds of stone or rock lime (or 6 pounds of hydrated lime), and 50 gallons of water; or for a smaller amount, 4 ounces of copper sulfate, 4 ounces of rock lime, and 3 gallons of water.

Wetting and sticking agents should also be added. The wetting agent is necessary to obtain a uniform spray deposit on the waxy daffodil leaves. Penetrol[3] is commonly used for this purpose in the Pacific Northwest, but some of the new materials such as DuPont Spreader Sticker may also be effective.

In case the ground is too soft to support spray machinery in early season, try dusting with monohydrated copper sulfate plus lime (20:80 parts by weight).

Destroy all mature foliage whenever possible, change the planting site from year to year, avoid sites with poor air and soil drainage, and practice thorough weeding.

It should be emphasized that if leaf diseases occur, they markedly affect the size of the bulb. For instance, growers have estimated a 30 per cent or greater reduction in bulb size caused by the disease known as "scorch" which killed foliage 4-8 weeks earlier than normal.

3. Begin roguing for mosaic when the plants are 6 inches high. Try to rogue them out before blooming time. Begin roguing decline immediately after the plants have bloomed.

The removal or roguing of plants affected with the two virus diseases, mosaic and decline, gives best control. Since it is sometimes impossible to rogue carefully the entire acreage of a commercial field, many growers have adopted a mother block or foundation

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[1] McWhorter, Frank P. and Freeman Weiss, *Diseases of Narcissus,* Ore. Agr. Expt. Sta. Bull. No. 304, 1932.

[2] Moore, W. C., *Diseases of Bulbs,* Bull. No. 117, Ministry of Agr. and Fisheries (London), 1939.

[3] Use type manufactured by Kay-Fries Chemicals, Inc. The effectiveness of this material on daffodils was first discovered by Dr. Glenn A. Huber, formerly plant pathologist at the Western Washington Experiment Station. Use it at the rate of 1 quart to 75 gallons Bordeaux mixture (4-4-50). First, measure out the desired amount of Penetrol and put in a clean container. Then add about three times its quantity of clean water, devoid of dirt of chemicals, and stir thoroughly. The two should mix readily. Add the Penetrol emulsion to the freshly prepared Bordeaux mixture with constant stirring to insure thorough mixing. The spray is then ready for application.

system,[4] whereby the largest well-shaped bulbs are saved and planted in a separate block. The major share of attention is then given to this particular stock, and all diseased plants are carefully rogued. When this mother block has been built up to a sufficient size, all bulbs used for propagation are taken from it.

4. Rogue for nematodes before flowering.

5. When the Fire disease is anticipated, remove and destroy old blooms.

6. Dig bulbs with as little bruising as possible and store under cool, well-ventilated conditions.

7. If nematodes are present, give the bulbs a hot water formalin treatment within three weeks after digging. Do this before treating with Ceresan.

To control nematodes, planting stock should be given a hot water treatment every two or three years.[5] Plants from bulbs treated within three weeks after digging seldom exhibit injury. Later treatments may, however, cause leaf markings, stunting, flower distortion, and blindness. Varieties differ in the degree to which they are affected by this treatment. Symptoms of hot water injury may be confused with those of mosaic.

8. Treat bulbs (planting stock only) with Ceresan to control basal rot, ten days after digging in the Pacific Northwest; somewhat earlier in drier, warmer areas. Careful culling will do much to keep this disease in check. If basal rot is present in more than one-half of one percent of the stock, it is wise to disinfect the bulbs with Ceresan. This material contains mercury and injures some bulbs if they are treated immediately after digging. Unfortunately the latter time is the best time to treat them in order to control the disease. Mercury injury shows up as a stunting of shoots and flowers, with the perianth segments proportionately narrower than usual and the trumpet constricted at the opening.

Since mercury compounds may cause a skin rash on some persons, the use of rubber gloves is advisable.

Although the Ceresans (2% and New Improved) are the best materials now known for controlling basal rot, we have been trying since 1941 to find another compound which is safer to use on bulbs immediately after digging. Over 400 materials have been tested, and a few appear to be promising. One of these is Puratized Agricultural

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[4] The credit for initiating this practice in the Pacific Northwest goes to Dr. F. P. McWhorter of the Oregon Agricultural Experiment Station.

[5] Full details on construction of treating tanks will be published in the near future by W. D. Courtney (U.S.D.A., Division of Nematology) and Dr. E. P. Breakey (Western Washington Experiment Station).

Spray, another mercury compound, but one which apparently is less harmful to bulbs than the Ceresan compounds.

Treating bulbs for one hour in hot water (110° to 111° F.) with formalin added (in the proportion of one pint to 25 gallons) has been reported to give good control of certain bulb and leaf diseases in Canada.

9. Plant in cool, well-drained soil which has not had narcissus on it for at least three years. Avoid planting on soils having large amounts of nitrogen or undecomposed organic matter.

Key to Narcissus Diseases Described in Detail in this Bulletin

In the pages which follow are descriptions, illustrations, and control recommendations for the most important narcissus diseases in Washington. The reader is referred first to the key to enable him to identify any particular narcissus disease at hand, and then to the page references. The account of each disease is to be found on the page indicated. Following each disease description is one or more references to other publications recommended as a source of additional information.

1. Leaves yellowed and stunted; bulb affected with a soft, chocolate-brown rot.....**Basal Rot (p. 7)**

2. Leaves brown and "crumpled" or sickle-shaped as they emerge from the ground; dead areas sometimes covered with a velvety-gray mass of spores.....**Smoulder (p. 11)**

3. Leaves with definite dead tips or spots.

A. Spots reddish-brown, most frequent near ground level, appearing after flowering and sometimes causing leaves to collapse.....**Fire (p. 13)**

B. Leaf tips dead and brown, sometimes covered with a white mildew-like layer.....**White Mold (p. 15)**

C. Leaf tips dead early in season, yellow, red or brown in color and bearing numerous small dark bodies (pycnidia); reddish-brown scab-like spots often present below tips.....**Scorch (p. 16)**

4. Leaves mottled in color.

A. Yellow-green mottles or streaks scattered on leaves.....**Mosaic (p. 19)**

B. Yellow, purple or white narrow streaks, sometimes dead, tan tips.....**Decline (p. 21)**

5. Leaves distorted and exhibiting yellow-green pimples (spikkles).....**Nematode (p. 23)**

BASAL ROT[6]

Symptoms: Roots are few or lacking; basal plate of the bulb is partially or entirely decayed with a soft chocolate-brown (occasionally reddish-brown) rot which usually spreads into the scales; a white or pinkish-white fungus mass is often present on the base of the bulb, between the scales, or between the slabs and mother bulb. Occasionally the decay may begin at the tip of the bulb and progress downward. The causal fungus rapidly rots bulbs under warm (above 70° F.) storage conditions. In the field the shoots arising from diseased bulbs are sometimes stunted, turn yellow, and die prematurely. Infection occurs through mechanical injuries, openings between slabs and through the neck, but usually through the roots and basal plate.

Causal Agent: *Fusarium oxysporum* f. *narcissi* (Cke. and Mass.) Sny. and Hans. (*Fusarium bulbigenum* Cke. & Mass.), Macroconidia sharp curved, pedicellate, mostly 3-septate and measuring 3-4.5 x 25-44u; microconidia and chlamydospores also formed; mycelium white to blue on agar.

Importance: Serious; widespread; more severe in warm climates than in cool ones such as the Pacific Northwest.

Miscellaneous: Many of the "bi-colors," such as Spring Glory and Emperor, are especially susceptible; the popular King Alfred is less susceptible and the Poetaz, Jonquilla, Polyanthus, and most of the Incomparabilis, Barrii and Leedsii varieties are resistant. The disease is more common in double nose and mother bulbs than in rounds. The fungus overwinters in diseased bulbs and in infested soil. Most infection probably occurs during digging, grading, and planting when healthy and diseased bulbs are mixed together. In warm climates the fungus spreads through the soil from diseased bulbs to healthy ones.

Control:

1. Avoid sunburning, bruising or otherwise injuring the bulbs.

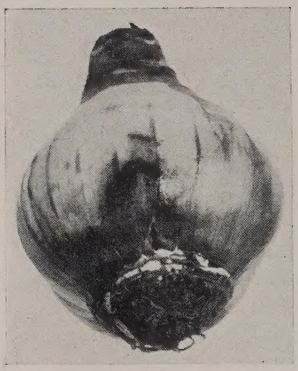
2. Dry bulbs as rapidly as possible after digging.

3. Examine stock very carefully and destroy all diseased bulbs. Discard all of severely-infected stocks to prevent them from contaminating healthier stocks.

4. Store in thin layers under cool (50-60° F.), well-ventilated conditions. Avoid heating in transit.

5. Dip bulbs (planting stock only) for two minutes in a Ceresan solution 10 days after digging. "2% Ceresan" (1 lb. in 8 gals. of water) is recommended in the Pacific Northwest, and the New Improved Ceresan (1 lb. to 40 gals. of water) in warmer areas. The

[6] Gregory, P. H., "The Fusarium Bulb Rot of Narcissus." *Ann. Appl. Biol.* (1932) 19:475-514.



Surface view of a partially rotted bulb

Base of a rotted bulb showing white growth of fungus around basal plate

Longitudinal section of a diseased bulb

Cross section of a diseased bulb

Fig. 1.—Basal Rot Symptoms.

addition of a wetting agent is beneficial. Dry rapidly after treatment.

6. Sort again before planting and destroy bulbs that have rotted since the first sorting.

7. Plant in cool, well-drained soil and as deep as practicable. Rows should never be opened so long ahead of the planters that the soil at the planting level may warm up before the bulbs are placed. In cool climates, such as the Pacific Northwest, replant as soon as possible. If the bulbs are shallow-planted, hilling up the rows will help to keep the ground cool.

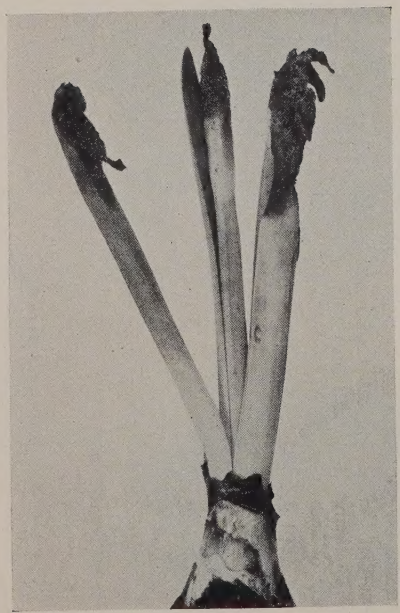
8. Avoid soils and fertilizers high in nitrogen. If green manure crops or cow manure are used, it is advisable to mix them thoroughly with the soil early enough to permit decomposition before planting the bulbs.

9. Do not replant daffodils on the same land oftener than once every three years in cool areas, such as the Pacific Northwest, and longer in warmer regions.

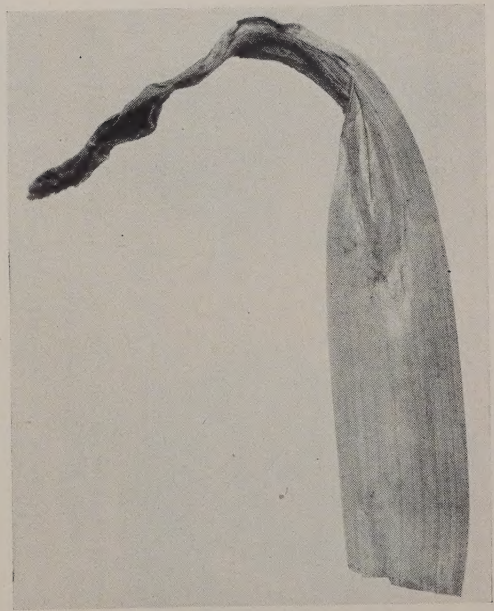
10. Disinfect used trays and cases in a solution of formaldehyde at a rate of 1 quart (U.S.P.) to 5 gallons of water.

11. Results to date at the Western Washington Experiment Station and the Plant Industry Station at Beltsville, Maryland, indicate that the new compound, Puratized Agricultural Spray, is promising as a dip in place of the 2% Ceresan. It appears to injure bulbs less than the 2% Ceresan. Other promising materials are being investigated.

12. Preliminary experiments in the eastern United States have shown that the application of 25 to 40 pounds of mercuric oxide plus 200 pounds of aluminum sulfate per acre may reduce the amount of basal rot fungus in the soil.



Typical appearance of diseased leaf tips



A blighted leaf bearing gray masses of spores on the tip

Fig. 2.—Symptoms of Smoulder.

SMOULDER[7]

(Botrytis)

Symptoms: Young leaves arising from diseased bulbs may be crumpled, yellowed or browned, and dead. Older leaves may be affected with a wet, pinkish-brown rot on one side at or near the soil line. On the young, blighted plants are produced a mass of gray conidia which may cause brown spots on the flowers. In prolonged storage, infected bulbs may occasionally exhibit a yellowish-brown rot.

Causal Agent: *Botrytis narcissicola* Kleb. Conidia are oval, somewhat pointed at the lower end, pale brown, and measure 8-16u x 7.5-12u; small, black, flattened sclerotia may develop under or on the surface of the outer papery scales, or on the young blighted shoots.

Importance: Minor, but occasionally of severe local importance; widespread; worse in cool, wet seasons.

Miscellaneous: This fungus is a definite, although weak, parasite. Early blooming narcissus varieties are especially susceptible.

Control:

1. Remove and burn all malformed or obviously unhealthy plants as they emerge.
2. Discard all diseased bulbs.
3. The hot water treatment for nematodes helps to keep this disease in check.
4. Dig every year.
5. Rotate.
6. When planting, avoid frost pockets and heavy or waterlogged soils.
7. Practice wide spacing and clean cultivation.

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[7] Moore, W. C., *Diseases of Bulbs,* Bull. No. 117, Ministry of Agr. and Fisheries (London), 1939.

Collapse of leaves caused by the Fire Fungus

Typical decay of flower stems

Fig. 3.—Symptoms of Fire.

FIRE[8]

(Polyblastis)

Symptoms: Small, watery or light brown spots appear first on the flowers. Under moist conditions the flowers are rapidly destroyed and large ashen gray watery spots appear on the stems below the flowers. Next, the leaves develop bright yellowish elongated spots which later turn chocolate or reddish-brown. These spots usually are confined to the center of the leaves and are generally near the tips. In warm moist weather the leaves may be completely killed within a few days. Apparently the bulbs are not attacked, but the fungus lives over the winter as sclerotia produced in the leaves.

Causal Agent: *Sclerotinia polyblastis* Gregory (*Botrytis polyblastis* Dowson). Conidia are spherical or pear-shaped, light brown, papillate at one end, very wide (30-90u), and produce several germ tubes. Microconidia may form in culture and on sclerotia. The latter are large (up to ½″ in length), flat, black and smooth. They form readily under moist conditions on dead leaves, sometimes preceded by the development of a few small tufts of conidia.

Importance: Usually rare; English Isles and Pacific Northwest; worse during warm moist seasons.

Miscellaneous: Considerable variation in resistance; the trumpets, bicolors, jonquils, and varieties of *Narcissus tazetta* are quite susceptible, while Mosaic-free Minister Talma seems resistant. Early varieties, such as "The First," are especially susceptible.

Control:

1. Remove flowers before they mature.
2. Destroy infected leaves.
3. Spray plants and adjacent ground with 4-4-50 Bordeaux plus a wetting and sticking agent.
4. Dig every year.
5. Rotate.
6. Practice wide spacing and clean cultivation.

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[8] Dowson, W. J., "On an extraordinary Botrytis causing a disease of Narcissus leaves," *Trans. Brit. Mycol. Soc.* (1928), 13:95-102.

Field view of diseased plants

Diseased leaf tips, showing white masses of spores

Fig. 4.—Symptoms of White Mold.

WHITE MOLD[9]

(Ramularia blight)

Symptoms: The early stages appear as sunken grey spots or streaks on leaves, especially towards the tips. These spots enlarge, becoming yellowish-brown and, during moist weather, covered with white powdery spore masses. As the season advances, sclerotia develop on the older parts of the lesion. In severe attacks the foliage dies prematurely. Flower stalks may also be decayed, but bulbs are supposedly not attacked although there is some proof that the fungus can survive in dead infected leaf bases which remain attached to the bulbs.

Causal Agent: *Ramularia vallisumbrosae Cav.* Conidia which are formed in white powdery masses on leaves are hyaline, cylindrical, one to many celled, and 2.5-4 x 3-95u in size. Very small black sclerotial-like bodies (70-140u, roughly spherical with a short "neck") which are formed in the dying leaves carry the fungus over the winter and the next spring produce spores that infect new leaves.

Importance: Minor, but occasionally serious in 2-year old plantings; widespread; worse under warm, moist conditions. It apparantly is confined to Narcissus.

Miscellaneous: Varieties differ in resistance, King Alfred being fairly resistant and Golden Spur quite susceptible. Spread of the fungus is checked during cool dry weather, but under warm moist conditions it can destroy all foliage within three to four weeks.

Control:

1. Remove and burn infected leaves and flowers.
2. Begin spraying with 4-4-50 Bordeaux plus a wetting and sticking agent when leaves are 4-5 inches high.
3. Dig every year.
4. Disinfect bulbs according to the treatment recommended for basal rot.
5. Rotate.
6. Provide good air circulation by wide spacing and weeding.

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[9] Gregory, P. H., "The Life History of *Ramularia vallisumbrosae Cav.* on Narcissus," *Trans. Brit. Mycol. Soc.* (1939), 23:24-54.

Flower stem exhibiting typical diseased spots

Fig. 5.—Symptoms of Scorch.

SCORCH[10]

(Stagonospora)

Symptoms: Leaf tips dead, somewhat wrinkled and yellow, red or brown in color as they emerge from the soil, a condition often wrongly ascribed to frost. Under moist conditions, the leaves

[10] Creager, Don B., "Leaf Scorch of Narcissus," *Phytopathology* (1933) 23:770-786.

continue to die downward from the tips and secondary, reddish-brown elongated spots (⅛" x ½" or smaller) develop lower down on the leaves as they lengthen; eventually the tissue surrounding these spots dies and becomes light grayish-brown; tissues below and above these areas turn yellow and wither, so that the leaves often fade and die prematurely and the planting appears "scorched"; on the dead leaves the lesions then appear as somewhat raised, scabby dark reddish-brown areas. Except in southern regions the disease usually does not become serious until flowering, but under certain conditions it can cause flower spots which may be inconspicuous at picking time but enlarge during transit to market.

Causal Agent: *Stagonospora curtisii* (Berk.) Sacc. Conidia are hyaline, elliptical to fusiform or nearly cylindrical, rounded at the ends, 1-6 celled, and 3-8u x 4.5-28u in size. They are formed in brown to dark brown lobose pycnidia (110-275u) in large numbers in the dead leaf spots and are spread by raindrops or irrigation. The fungus is carried on the nose of the bulb where overwintered spores infect the new, emerging shoot.

Importance: Usually moderate but occasionally serious; widespread; worse in warm moist seasons. The fungus also has been reported on Amaryllis, Crinum, Sprekelia, Sternbergia and Galanthus.

Miscellaneous: Varieties of Polyanthus, Poeticus, and Leedsii are especially susceptible, but King Alfred, Sir Watkin, Victoria, and other trumpet types also are attacked. Plants affected with mosaic are especially susceptible to infection by this fungus.

Control:

1. In small plantings, pick off and burn infected leaf tips as soon as they emerge.

2. Begin spraying with 4-4-50 Bordeaux plus a wetting and sticking agent when leaves are 4-5 inches high.

3. Destroy mature foliage.

4. Soak bulbs prior to planting in (1) formaldehyde (1 pt. in 25 gals. water) for 2 hours; (2) water for 1 hour, followed by a 30-minute dip in either mercuric chloride (1 oz. in 6 gals. water) or formaldehyde (1 pt. in 15 gals.); or follow the hot water treatment recommended for nematodes. Because 2% Ceresan contains mercury, it too probably would be effective if used according to the directions given for basal rot.

5. Rotate.

6. Practice with wide spacing and thorough weeding in order to provide good aeration.

Fig. 6.—Symptoms of Mosaic. Upper left, mosaic-stunted plant on left, healthy plant on right. Upper right, leaf mottling. Lower left, leaf roughening. Lower center, white streaking of perianth (tube removed). Lower right, leaf twisting.

MOSAIC[11]

(Gray disease, yellow stripe)

Symptoms: Plants are stunted; leaves exhibit light green, grayish-green, dull to bright yellow or brown stripes or mottles, mostly confined to the upper two-thirds of the leaf; leaves may be twisted or distorted and narrow bands of the epidermis roughened; small white streaks or blotches may appear on the flowers which are reduced in size; severely infected plants mature earlier than normal and consequently the bulbs are reduced in size and the yield is often one-fourth less than for comparable healthy stock. Discoloration from hot-water treatment also results in a mottled condition but without the roughening typical of mosaic.

Causal Agent: Narcissus-mosaic virus; inactivated at 70-75° C; dilution end point between 1:100 and 1:200; does not pass Pasteur-Chamberland filters L2, L5 or L7; transmitted by bulb grafting, sap, and various aphis.

Importance: Serious; widespread; only on Narcissus.

Miscellaneous: Most transmission occurs when "daughter" bulbs are taken from infected "mother" bulbs; seeds do not carry the virus but bulbs do. *Narcissus tazetta, poeticus* and *cyclamineus* appear to be most resistant.

Control:

1. Remove diseased plants, beginning when the foliage is 6 inches high and finishing before the end of the flowering period, since it is during the earlier period that mosaic symptoms are most evident. If more than 50 per cent of the plants are affected, it may be easier to remove only the healthy ones, replanting them in a separate location.

2. If aphis appear, spray or dust with either a proprietary rotenone-insecticide (follow the manufacturer's directions), or nicotine sulfate. Use the latter only during warm weather (above 70° F.) and at a rate of 1 pint of 40% nicotine sulfate in 100 gallons of water with 4 pounds of soap added. It can also be added, without soap, to a Bordeaux-Penetrol spray. When used as a dust, 4% nicotine should be present.

3. Since severely diseased plants produce small bulbs, it is advisable to select and retain for planting stock only the largest ones.

4. Plant mosaic-free stocks (especially foundation or "mother" stocks) at least 50 feet from all newly purchased stock and from all incompletely rogued stock.

5. Seedling stocks may be protected by fine-mesh cheesecloth cages which keep out aphis and other insect vectors.

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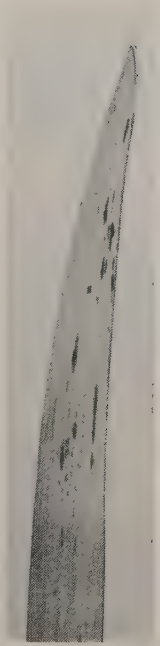
[11] Haasis, Frank A., *Studies on Narcissus Mosaic,* Cornell Agr. Exp. Sta. Memoir No. 224, 1939.



Purple streaking

White streaking

Paper tip

Fig. 7.—Symptoms of Decline.

DECLINE[12]

(White streak, paper tip, purple streak, silver streak, zilverblad)

Symptoms: First symptoms appear on leaves and flower stems as narrow (1/16″ or less) dark green or purple streaks of varying lengths, which later become white, yellowish-white or gray; high temperatures hasten development of the white streak stage. Death of the tip of the leaf (called paper-tip) may occur independently or coincidentally with the white streak symptoms. The symptoms of this disease differ from those of mosaic in that the latter appear earlier in the season, are more blotched or mottled rather than streaked, and the foliage is somewhat roughened.

Causal Agent: Narcissus white-streak virus; transmitted by sap and by various aphis.

Importance: Serious; widespread; only on Narcissus.

Miscellaneous: Probably is spread more by propagation than by aphis or other vectors. Bulbs carry the virus but seeds do not. The large trumpet varieties apparently are the most susceptible.

Control:

1. Remove diseased plants and bulbs, beginning after blooming; if considerable decline is present, it may be better to remove only the healthy plants, replanting these in a separate location to start the foundation stock; bulbs affected with decline can be sold as second grade for forcing, since the disease is unlikely to show up in the greenhouse to any extent.

2. If aphis appear, spray or dust with either a proprietary rotenone-insecticide (follow the manufacturer's directions), or nicotine sulfate. Use the latter only during warm weather (above 70° F.) and at a rate of 1 pint of 40% nicotine sulfate in 100 gallons of water with 4 pounds of soap added. It can also be added, without soap, to a Bordeaux-Penetrol spray. When used as a dust, 4% nicotine should be present.

3. Since severely diseased plants produce small bulbs, it is advisable to select and retain for planting stock only the largest ones.

4. Separate foundation blocks from other plantings.

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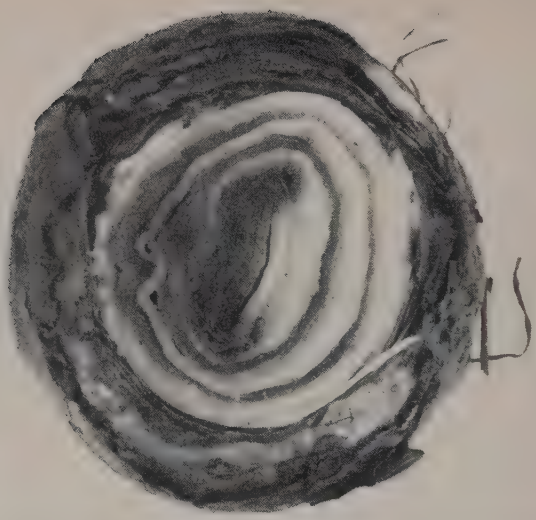
[12] Haasis, Frank A., "White Streak, a Virus Disease of Narcissus," *Phytopath.* (1939), 29:890-895.



Cross section of a bulb showing rings of diseased tisue. Compare with the appearance of a basal rot-infected bulb in Fig. 1, lower right. (Photo by Bureau of Plant Industry, Soils and Agricultural Engineering, U.S.D.A.)

Different types of leaf symptoms

Fig. 8.—Symptoms of Nematode Attack.

BULB OR STEM NEMATODE[13] [14]

(Eelworm)

Symptoms: Severely diseased bulbs produce little or no foliage, while those less affected may be twisted, distorted, and exhibit: (1) corrugated leaf thickenings near bases of leaves; (2) marginal discolorations; (3) pale yellow or yellowish-brown pimples (spikkles). The pimples in the center of leaves are larger than those at the edge, but the latter are the easiest to detect in the field. Such marginal pimples appear as bulges, usually with sunken centers. Infected bulbs may be completely or partially rotted. In the latter case they show one or more rings of brown, disorganized scales lying between white healthy ones. The early stage starts with yellowish spots in neck region, whereas basal rot, with which it might be confused, usually begins at the base.

Causal Agent: *Ditylenchus dipsaci* (Kuhn) Filip. If possible, determinations concerning nematodes should be referred to a nematologist because of the highly specialized nature of the diagnosis. However, it is probable that if nematodes are found in typical leaf "spikkles" they belong to the species *D. dipsaci*. If they are found in bulbs in all stages (egg, larval and adult) and the adults possess a "spear" at the head end, they *may* be *D. dipsaci*. Certain other parasitic forms also exhibit these qualities. The spear is an interior, rod-like organ with a knobbed end, and about as long as the head is wide. Most saprophytic forms found in daffodil bulbs are proportionately wider than *D. dipsaci*. The latter is 1.0-1.3 mm long.

Importance: Serious; world-wide.

Miscellaneous: This nematode is slender, less than 1/20th of an inch long, and cannot be seen by the unaided eye. Nematodes enter the leaves as the latter emerge from the soil and are carried up as the leaves elongate. When the foliage begins to dry up in the summer, the nematodes tend to migrate into the bulb where they overwinter. This species of nematode attacks many different plants, but it is possible that additional studies may prove that the type on narcissus will not live on other plants, and vice versa. They can survive without additional food for about 18 months in moist soil free of vegetation.

Control:

1. Remove and burn, or bury deeply and cover with quick lime, all infected plants and bulbs.

2. Harvest infected lots slightly earlier than normal.

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[13] Hodson, W. E. H., *Narcissus Pests,* Bull. No. 51, Ministry of Agr. and Fisheries (London), 1939.

[14] Chitwood, B. G. and F. S. Blanton, "An Evaluation of the Results of Treatments Given Narcissus Bulbs for the Control of the Nematode *Ditylenchus dipsaci* (Kuhn) Filip," *Jour. Wash. Acad. Sci.* (1941), 31:296-308.

Types of flower injury resulting from hot water treatment at the wrong time. Normal flowers in top row, injured ones below

Leaf spotting (left) and blindness of flower stems (right), caused by injury resulting from hot water treatment at the wrong time

Fig. 9.—Symptoms of Hot Water Injury.

3. Within 3 weeks after digging, treat planting stock in a hot water bath (110-111° F.) to which has been added formaldehyde (U.S.P.) in the proportion of 1 pint to 25 gals. of water. Treat for four hours after bath is stabilized at 110° F. Severely infected bulbs which are exceedingly dry may benefit from a two-hour presoak in water at 70-80° F. before treating at 110° F. Dry promptly, or have field ready and plant immediately.

4. Treat planting stock regularly every two or three years.

5. Disinfect used trays, cases, tools, and equipment by: (1) treating with steam; (2) dipping in hot water at 185° F.; or (3) dipping in a solution of one part formaldehyde to nine parts of water.

6. Do not plant daffodils back on the same ground for three years, unless infested ground is sterilized with chloropicrin or DD mixture (dichloropropylene and dichloropropane).

7. Until more is known of the exact host range of the type of nematode found on daffodils, it is best to avoid using other types of bulbs and perennial crops in the rotation program on infested soil.

MISCELLANEOUS DISEASES

Wet-Scale Rot: Caused by *Sclerotium rolfsii* Sacc. and *S. delphinii* Welch. More common in warm climates than in cool ones, such as the Pacific Northwest. The fungus produces a light reddish-brown rot with white streaks, slimy at first and woody later. Small (1/16" to 3/16"), more or less circular, reddish-brown sclerotia are sometimes present in or on the scales. The former can live for several years in the soil. The same fungus attacks bulbous iris, lilies, and many other plants as well as narcissus. To control it, remove all infected plants and treat the soil with a fungicide (such as formaldehyde or chloropicrin), fallow the ground, or replant with some resistant crop (such as corn, rye, and other cereals, clover or cowpeas) for at least two years. Disinfecting the bulbs according to the basal rot treatment probably would be of benefit.

Dry-Scale Rot: (Black scale-speck). Not much is known about this disease as yet. The disease is evident as a dry rot of the upper portions of the outer scales, primarily on bulbs grown in heavy wet soils. The disease gets one of its names from the fact that there are produced on the outer scales large numbers of very small black sclerotia, which are just specks to the unaided eye. Treatment as for basal rot control and planting on well-drained soil should keep this disease in check.

Soft Rot: Caused by the ordinary black bread mold, *Rhizopus nigricans Ehr.;* a dark soggy rot of the basal plate develops only under very warm (85° F.) temperatures with poor ventilation, and especially in bulbs injured mechanically or by sunburn. It is prevented by keeping bulbs cool and well ventilated in storage and in transit, and by drying and cooling bulbs rapidly after the hot water treatment.

Mushroom Root Rot: The honey mushrooms *Armillaria mellea* (Vahl.) Quel., sometimes causes serious losses when bulbs are planted on newly-cleared ground. Affected bulbs are covered with a coarse white mold.

A few other diseases, either unknown in the United States or apparently of but slight importance, include white root rot (caused by *Rosellinia necatrix* Prill), Cylindrocarpon root rot, eelworm root rot, Penicillium bulb rot, Trichoderma bulb rot, smut, rusts, and some miscellaneous leaf spots.

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